Numerical Continuation of Families of Periodic Orbits in the Circular Restricted Three-Body Problem

Renyong Zhang

Key Laboratory of Space Utilization, Technology and Engineering Center for space Utilization, Chinese Academy of Sciences, 100094, Beijing, China.

Corresponding Author: Renyong Zhang. Email: zhang.renyong@csu.ac.cn.

This article aims to give a method for the fast numerical computation and continuation of families of periodic orbits in the strong nonlinear circular restricted three-body problem, and we focus our attention on those in the Earth-moon system. This work is primarily motivated by a series of missions and plans that take advantages of the three-body periodic orbits associated with the collinear equilibrium points, $L1$, $L2$ and $L3$ or two gravitational celestial bodies. We describe the method used that allows to follow individual families of periodic orbits by numerical continuation, which based on Jacobi energy surface, of strong nonlinear equations. The stability of these bifurcation orbits of the dynamics is examined and it is found that in each case there are two subintervals of range of mass parameter for which these orbits are stable. The investigation shows that the method can fast generate a great families of the periodic orbits including Lyapunov Orbit, Halo Orbit, Near Rectilinear Halo Orbits (NRHOs), Butterfly Orbits, Distant Retrograde Orbits (DROs), and Direct Periodic Orbits (DPOs).

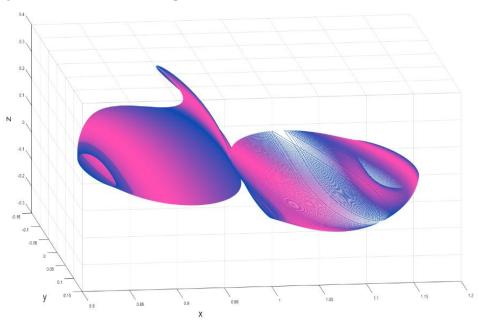The following are show some families of periodic orbits:

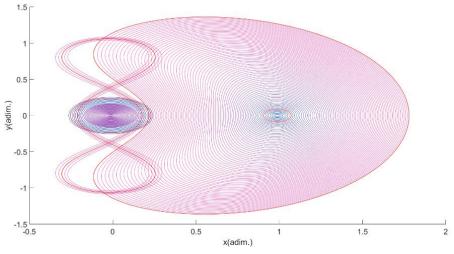**Figure 1:** Halo Orbits family of Earth-moon system
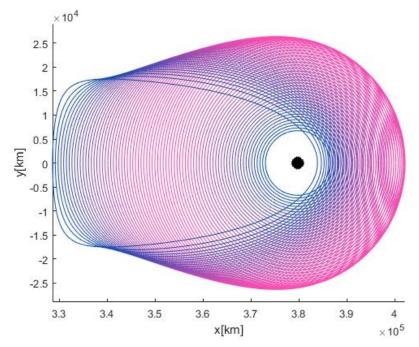
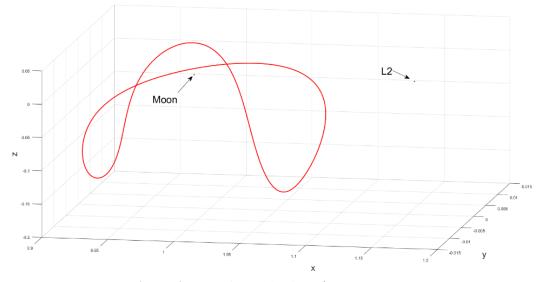**Figure 2:** DROs family of Earth-moon system

Figure 3: DPOs family of Earth-moon system

Figure 4: Butterfly Orbit of Earth-moon system